Active projects are summarized in this report. The summaries include: the title of the project, the contract duration of the project, the names of the contractor and principal investigator, the sponsoring Technical Committee or Task Group, or other committee monitoring the research and a brief description of the project.

(P) – Projected end date

1196-RP
DEVELOP SOFTWARE TO CALCULATE THE APPLICATION SEASONAL EFFICIENCY OF COMMERCIAL SPACE HEATING BOILER SYSTEMS BASED ON ASHRAE STANDARD 155P

September 2000 – July 2017 (P) (Completion tied to Standard 155)
Iowa State University
Principal Investigator, Ron Nelson
TC 6.1, Hydronic and Steam Equipment and Systems

Boilers are estimated to account for 42% of space heating energy use in the commercial and multifamily sectors in the U.S. Significant energy savings could be achieved in commercial and multifamily buildings by optimizing the selection of commercial boiler systems in new buildings and at the time of boiler replacement. Currently, however, commercial boilers and all other types of commercial heating equipment are rated only in terms of steady-state efficiency at full load, which does not provide a meaningful indication of relative operating costs.

The objective of this research project is to develop user-friendly windows-based software will greatly accelerate adoption of seasonal efficiency analysis for commercial boiler systems. A significant obstacle to the use of any new standard is the learning curve for users to become familiar with the new terminology and inputs and learn how to do the computations. With this software, the level of effort required of new users of the standard will be dramatically reduced, and can be focused on the more important tasks of evaluating outputs and developing an intuitive sense of the factors that affect the seasonal efficiency of commercial boiler systems.

1262-RP
RELATE AIR QUALITY AND OTHER FACTORS TO COMFORT AND HEALTH RELATED SYMPTOMS REPORTED BY PASSENGERS AND CREW ON COMMERCIAL TRANSPORT AIRCRAFT (PART 2)

January 2007 – June 2017 (P)
Battelle Memorial
Principal Investigator: Ann Louise Sumner
TC 9.3, Transportation Air Conditioning

The principal aim of this research project is to relate perceptions of discomfort or health related symptoms of flight attendants and passengers to possible causal factors, including cabin and bleed air quality and other factors such as reduced air pressure, jet lag, inactivity, humidity, flight attendant duty schedule and fatigue, circadian rhythm, stress and noise. In particular, the following specific objectives are to be addressed in Part 2 of this project:

1. Measure and characterize contaminants in cabin air that are introduced via ECS in a variety of airplane types.
2. Measure and characterize contaminants in cabin air that are not introduced via ECS. Ventilation rates shall be assessed.
3. Quantify the effect of aircraft type, maintenance, APU, engine age and operations-related parameters on cabin and bleed air quality
4. Investigate relationship of the measured cabin air contaminants, ventilation rates and other factors with reported symptoms among passengers and flight crew.

1327-RP
FLOW REGIME AND PRESSURE DROP DETERMINATION FOR TWO-PHASE AMMONIA UPWARD FLOW IN VARIOUS RISER SIZES

April 2007- January 2016 (P)
Teknologisk Institut (DTI)
Principal Investigator, Thomas Lund
TC 10.3, Refrigerant Piping
IIAR $10,000 co-funder

This ASHRAE research project will have a significant worldwide energy impact and an annual monetary savings that is far in excess of the project cost. The advancement to the state of the art will be the publication in the ASHRAE handbooks a set of design curves that will define the optimal suction riser velocity for a range of pipe diameters and temperatures. This information will be the only data of its type available in the public domain at these pipe size ranges and with ammonia. It will be used by industrial refrigeration system design engineers and plant operating engineers worldwide.

The objective of this research project is to determine the minimum vapor velocity required to sustain vertical upward flow of liquid anhydrous ammonia when transported by vapor anhydrous ammonia in the same pipe. This velocity shall be determined for a range of pipe diameters, overfeed rates, and temperatures. The pressure drop per foot of pipe as a function of velocity, temperature, and overfeed rate will also be determined.

1385-RP
DEVELOPMENT OF DESIGN TOOLS FOR SURFACE WATER HEAT PUMP SYSTEMS (SWHP)

September 2009 – January 2016 (P)
Oklahoma State University
Principal Investigator, Jeffrey Spitler
TC 6.8, Geothermal Energy Utilization.

Surface water heat pumps are a relatively inexpensive but highly efficient heating and cooling alternative. In some applications, direct cooling or pre-cooling is possible without refrigeration, even in moderate climates because of naturally-occurring thermal stratification. However, little effort has been devoted to developing public domain design tools. Although a great deal of information is available from geological surveys regarding characteristics of surface water, HVAC engineers are unfamiliar with how to locate and apply this information. Finally, overloading a reservoir or stream may result in extreme temperature variations, water level fluctuations, SWHP system failures, and environmental problems. Designers need tools to optimize this important HVAC option and avoid undesirable misapplications. The objective of this project is to provide improved design data and design tools for SWHP systems. The scope includes collection, interpretation, and collation of design data; experimental measurement of convection coefficients on submerged heat exchanges, and development of design tools.

1399-RP
SURVEY OF PARTICLE PRODUCTION RATES FROM PROCESS ACTIVITIES IN PHARMACEUTICAL AND BIOLOGICAL CLEANROOMS

April 2014 – March 2016
University of Oklahoma
Principal Investigator, Dr. Li Song
TC 9.11, Clean Spaces

The intent of this research project is to gather empirical data on particulate generation rates for various cleanroom processes. That empirical data, correlated to the surveyed activities and operations will then be used to develop a design guideline which will show a range of particulate generation rates for different cleanroom operations. This

guideline will help engineers, owners and contractors to arrive at a better design solution which meets the required performance levels but does not yield an oversized or inefficient system. The guideline would be included in the Handbook Chapter or in a separate Cleanroom Design Guideline if such a document were to be published by ASHRAE. As there is no other compendium of particle generation rates across the affected industries, we anticipate that this guide would take the dominant position in the marketplace.

1408-RP
THE EFFECT OF LINING LENGTH ON THE INSERTION LOSS OF ACOUSTICAL DUCT LINER IN SHEET METAL DUCTWORK

September 2008 – July 2016 (P)
University of Nevada-Las Vegas
Principal Investigator, Doug Reynolds
TC 2.6, Sound and Vibration Control

The incremental sound attenuation values (expressed in dB/ft and dB/m) for acoustically lined ductwork that are in the ASHRAE Applications Handbook are based on tests conducted on a very small sample of duct sizes, and are misleading in that they permit the assumption that the liner attenuation is linearly proportional to duct length. The proposed research will help TC 2.6 modify the incremental attenuation values to show how they depend on duct length so that air distribution system designers can minimize the use of acoustical duct liner while achieving the necessary noise reduction that it provides.

1414-RP
UPDATE OF U-FACTORS, SOLAR HEAT GAIN COEFFICIENTS AND VISIBLE TRANSMITTANCES OF STANDARD FENESTRATION UNITS MADE FROM REPRESENTATIVE FENESTRATION FRAME AND GLAZING SYSTEMS IN THE FENESTRATION CHAPTER OF THE HANDBOOK OF FUNDAMENTALS

September 2015 – November 2016
DesignBuilder Software
Principal Investigator: Bebojsa Stojanovic
TC 4.5, Fenestration

This project would update the tables in the Fenestration Chapter of the Fundamentals Handbook to reflect the most current methodology used for simulation of fenestration systems by industry and rating organizations. . This new methodology is based on ISO 15099 (ISO 2003), which in turn was developed based on
ASHRAE SPC 142P.

1450-RP
TRANSPORT OF CONTAMINANTS FROM GARAGE ATTACHED OR INTEGRAL TO LOW-RISE RESIDENTIAL BUILDINGS

December 2013 – November 2016 (P)
University of Illinois
Principal Investigator: Paul Francisco
SSPC 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. Co-sponsored by: TC 4.3, Ventilation Requirements & Infiltration

The results from this project will help ASHRAE members (including HVAC designers, IAQ consultants, researchers and other professionals) to better design low-rise residential buildings to improve occupant comfort, health and safety. The results will be particularly useful to SSPC62.2 and Guideline 24 consideration of ventilation requirements for attached garages. Possible new requirements for garage exhaust ventilation and air tightening are being considered and should be justified by field measurements. Standard 62-89 included a ventilation requirement for residential garages of 100 cfm per car, assumed to be met by leakage. However, the field and modeling studies that have been done to date make it clear that there are times when air leakage is inadequate to control contaminants

originating in garages. At times natural leakage is not only inadequate but contributes to contaminant transport into houses - sometimes resulting in serious injury or death.

1507-RP
BINARY REFRIGERANT FLAME BOUNDARY CONCENTRATIONS

September 2009 – July 2014 (P)
Safety Consulting Engineers
Principal Investigator, Andrew Kusmierz
TC 3.1, Refrigerants and Secondary Coolants
AHRTI $18k co-funder

ASHRAE and the industries they serve are faced with the need for new refrigerants to meet environmental, energy, and safety requirements. SSPC 34 will classify these working fluids for safe handling. To ensure the validity of flammability safety classifications issued by SSPC34, standard reference data is needed. Tools such as the proposed flammability property database will allow for the development of blends that are properly investigated and classified to meet demanding future needs.

1556-RP
CHARACTERIZATION OF LIQUID REFRIGERANT FLOW EMERGING FROM A FLOODED EVAPORATOR TUBE BUNDLE

September 2012 – February 2017 (P)
Kansas State University
Principal Investigator, Steven Eckels
TC 1.3, Heat Transfer and Fluid Flow

The primary objective of the research will be to experimentally determine the size distribution, velocity, and outflow and drop back of liquid refrigerant droplets emerging from the top of the tube bundle in a flooded evaporator. A parametric study is to be carried out to quantify the effects of surface geometry, fluid properties, and operating conditions on the droplet size distribution, velocity, and egress and regress.

1569-RP
CFD STUDY OF HYDRAULIC SHOCK IN TWO-PHASE ANHYDROUS AMMONIA

September 2014 – February 2017 (P)
ASCOMP USA
Principal Investigator: Djamel Lakehal
TC 10.03, Refrigerant Piping, Controls and Accessories

This computational fluid dynamic (CFD) research project is the extension of the empirical work completed in the prior laboratory study research project. Refrigeration system design engineers, refrigeration system controls engineers, valve manufacturers, and evaporator coil designers would be aided by this research. The research would provide the basis for design criteria for two-phase ammonia piping and evaporator coils. With the results from this research, the “Safety Considerations” section of Chapter 2, “Ammonia Refrigeration Systems,” in the Refrigeration Handbook could be expanded as well as the tabular data for hot gas defrost. Definitive results could become the basis for certain design requirements in ASHRAE Standard 15 not currently included. Design information and criteria could be written within one year of completion of the research project.

1573-RP
DETERMINATION OF SUITABLE REPLACEMENT FOR SF6 WHEN USED AS A TRACER GAS IN ACCORDANCE WITH ANSI/ASHRAE STANDARD 110

April 2017 – September 2018
Exposure Control
Principal Investigator: Tom Smith
TC 9.10, Laboratory Systems; Co-sponsored by: TC 5.8, Industrial Ventilation

The primary objective of this proposed research is to identify and validate one or more substitute tracer gases that could be incorporated into ANSI/ASHRAE Standard 110. There are a number of criteria that need to be considered in alternate gases including: availability and cost; ease of measurement; cost of measurement; environmental impacts; chemical stability; toxicity; accuracy of the measurement; correlation of alternate gas test results with existing Standard 110 tests; and others.

1588-RP
REPRESENTATIVE LAYER-BY-LAYER DESCRIPTIONS FOR FENESTRATION SYSTEMS WITH SPECIFIED BULK PROPERTIES SUCH AS U-FACTOR AND SHGC

September 2013 – August 2016
White Box Technologies
Principal Investigator: Joe Huang
TC 4.7- Energy Calculations

Develop a methodology to create representative detailed specifications for fenestration systems defined only by bulk properties such as U-factor and SHGC, and generic descriptions of the system, and implement this methodology as a computer program that can be used by engineers and building energy modelers without specialized knowledge of fenestration systems. For a given U-factor and SHGC, the methodology should produce a fenestration system that the fenestration and building industries would regard as realistic and representative, as well as all its thermal and optical properties needed to model this system in a building energy simulation program. If additional information on the fenestration system is available, as probably in 95% of the cases (either from visual inspection or product literature for actual products, or mandated for building standards calculations), the methodology should be flexible enough to incorporate this information so as to produce a representative fenestration system that has no discrepancy from its known properties. The goal for this software tool is to fill the missing pieces of input data to enable a detailed layer-by-layer simulation of the fenestration system, and not to develop a simplified non-physical model.

1590-RP
IMPLEMENTATION OF TOTAL COST OF OWNERSHIP (TCO) PRINCIPLES INTO HIGHER EDUCATION AS AN INTEGRATED DECISION MAKING TOOL

September 2009 – January 2016 (P)
APPA
Principal Investigator, Douglas Christensen
TC 7.8, Owning and Operating Costs

The research effort will focus on the “Implementation of Total Cost of Ownership (TCO) Principles into Higher Education as an Integrated Decision Making Tool”. This study will focus on the principles of TCO and will be in alignment with both interoperability and sustainability practices. APPA will invite up to 25 institutions to participate in this study. The data collected from these institutions will provide the necessary data for analysis and establishment of a “standard of practice” for the industry and could result in a Standard for applying TCO and/or a guideline for utilizing TCO in Facilities Management. The study will also help to significantly expand the ASHRAE Service Life and Operating Cost Database with additional buildings and equipment.

1604-RP
DEMAND CONTROLLED FILTRATION FOR CLEANROOMS

September 2011 – March 2017 (P)
Engsysco, Inc.
Principal Investigator, Wei Sun
TC 9.11 - Clean Spaces

Very little research has been done on dynamic control of airflow to control particles in cleanrooms - matching airflow to the desired contamination limits. The high energy use and resulting cost for typical systems today and concern over availability of electricity suggests that the ventilation rate should be adjusted in order to achieve the desired cleanliness yet minimizing excess airflow.

Up till now, this technology was not applied, as real time particle measurement systems did not have both sufficient precision, reliability, and cost effectiveness, and controls did not have adequate reaction time. Also owners and operators of industrial cleanrooms have been hesitant to make changes to the air exchange rates in cleanrooms due to misconceptions that varying flow rates through cleanroom filters will disrupt the flow and cause particle counts to increase.

The main objective of this project is to establish a scientific approach to implement demand controlled filtration (ventilation rate) for cleanrooms for the two cleanroom classes (ISO, 7 and 8, (10 000 and 100 000) that have the broadest application. For example, these two classes comprise 85 to 90% of pharmaceutical class rooms. Based on the results of this research, a future project could well research applying this approach to other more stringent classes.

1607-RP
DESIGN AND UTILIZATION OF THERMAL ENERGY STORAGE TO INCREASE THE ABILITY OF POWER SYSTEMS TO SUPPORT RENEWABLE ENERGY RESOURCES

April 2014 – January 2017
University of Wisconsin –Madison
Principal Investigator: Douglas Reindl
TC 6.9, Thermal Energy Storage

The principal goals of the research are to: Identify the additional value propositions TES provides for buildings, campuses (or micro-grids), and power systems that have large penetrations of as-available renewable energy. Develop a methodology to evaluate those value propositions. Quantify the magnitude of these value propositions for selected case studies constructed using actual utility data, weather data (wind and irradiance), and building load profile data. Relate the value propositions to the design (capacity and response rate) and operating parameters and dispatch strategy of TES systems, in order to begin to formulate a TES design procedure that optimizes the operational capabilities of the TES to compensate for the as-available nature of the renewable energy resources.

1615-RP
FAULT DETECTION AND DIAGNOSTIC (FDD) METHODS FOR SUPERMARKETS- PHASE I

April 2015 – July 2017 (P)
University of Nebraska
Principal Investigator: Yuebin Yu
TC 7.5 Smart Building Systems
Co-sponsored by: TC 10.07, Commercial food and Beverage Refrigeration Equipment

This research directly addresses the concept of sustainability, which is the underlying theme of the ASHRAE Strategic Research Plan. A typical supermarket (35,000 ft2 of sales area) in the U.S. and Canada consumes on the

order of 2 million kWh of electrical energy annually, which makes supermarkets one of the largest electric energy users per square feet in the commercial sector (Walker 2001; ASHRAE 2002). Supermarkets also "consume" a large amount of refrigerant. A typical supermarket has a charge of 3000 lbs to 5000 lbs of refrigerant and it is estimated that annual refrigerant losses are as high as 30% or more of the total charge (Walker 2001). The implication of these statistics is that the supermarket sector has a significant impact on global warming, not only from the point of view of energy consumed but, even more importantly, from the point of view of the impact of leaked refrigerant

1624-RP

EFFECTIVE ENERGY-EFFICIENT CLASSROOM VENTILATION FOR TEMPERATE ZONES

June 2014 – February 2017
Technical University of Denmark
Principal Investigator: Jørn Toftum

TC 2.1, Physiology & Human Environment

The project will identify affordable, efficient and effective solutions for achieving good classroom ventilation, by performing field intervention experiments in classrooms that are occupied and operating normally. Natural, hybrid and mechanical solutions will be compared in terms of thermal control, levels of airborne pollutants and OAS, the energy required by each system in a reference year, and, crucially, whether they actually improve children's performance of schoolwork.

1629-RP

TESTING AND MODELING ENERGY PERFORMANCE OF ACTIVE CHILLED BEAM SYSTEMS

December 2013 – May 2017 (P)
University of Colorado
Principal Investigator: John Zhai
TC 5.3, Room Air Distribution. Co-sponsored by: TC 4.7, Energy Calculations

Quantifying the operational performance of active chilled beams and the resulting sensible cooling capacity is necessary to correctly design, model or implement this equipment as part of building mechanical systems. Energy modeling software packages include chilled beam models, but no published data exist that document the range of accuracy achieved for these components.

The results of the project will provide a detailed assessment of the simulation capabilities of building energy simulation programs to predict the performance of active chilled beams and the resulting system performance of net-zero energy design strategies. Recommended modeling improvements will be available for program developers to implement in their respective energy simulation programs.

1634-RP
GUIDE FOR SUSTAINABLE REFRIGERATED FACILITIES AND REFRIGERATION SYSTEMS

March 2014 – February 2017 (P)
Massey University
Principal Investigator, Richard Love
Refrigeration Committee (REF)
Co-sponsored by: TC 10.5, Refrigerated Distribution & Storage Facilities, TC 10.1, Custom Engineered Refrigeration Systems

The Guide will serve designers, contractors and operators of refrigerated facilities and industrial and commercial refrigeration systems. The intent is that this Guide will be of broad interest in this sector in addition to designers, contractors, and operators, it will also be of value to educators, utilities, policy makers and others involved in the energy efficiency and sustainability ―business. Refrigeration systems are now evaluated as part of the efficiency

potential in projects seeking high efficiency levels and certification, rather than a pass through process load. The phase-out of HCFCs and the phase-down of HFCs will create a high level of interest in alternative refrigerants and system designs. Efficiency regulations, adoption of high efficiency green codes by states or local jurisdictions, and corporate adoption of sustainable policies that require a change in design premise from expert rule of thumb to a greater utilization of computerized energy analysis and life-cycle optimization.

1645-RP
DEVELOPMENT OF NEW ACCELERATED CORROSION TEST(S) FOR ALL-ALUMINUM MICROCHANNEL AND TUBE AND FIN HEAT EXCHANGERS

April 2014 – March 2017
University of North Texas
Principal Investigator, Seifollah Nasrazadani
TC 8.4, Air-to-Refrigerant Heat Transfer Equipment

The objective of this research is to develop a new corrosion test, or justify the use of an existing standardized accelerated test, for both all-aluminum tube and fin and brazed microchannel heat exchangers. The PI will first need to perform extensive literature searches to determine if existing accelerated tests are deficient. The PI will work with the approach discussed above by Scott et al and ISO standards to connect the work to what is known of atmospheric corrosive severity. The corrosion system takes into account the operating mode and the resulting temperature-humidity complex. The PI may work with an existing standard test or another corrosion-accelerant loading protocol if the literature survey points in that direction, particularly with respect to the corrosion morphologies. Regardless of any literature review findings, there must be a plausible and reasonable linkage between a measureable atmospheric corrosion system and the corrosion damage accumulation of aluminum heat exchangers. Therefore, it is expected that the final outcome of this work will be a standardized test that ASHRAE members can use to better predict HVAC&R component and system performance for a given family of alloy systems based upon the atmospheric conditions and mode of operation of an HVAC/HEX.

1649-RP
IAQ AND ENERGY IMPLICATIONS OF HIGH EFFICIENCY FILTERS IN RESIDENTIAL BUILDINGS

April 2016 – March 2018
University of Toronto
Principal Investigator, Jeffrey Siegel
TC 2.4, Particulate Air Contaminants and Gas Contaminant Removal Equipment

Filters are usually present in well-maintained forced air systems in the U.S., including in residential systems with recirculation airstreams. The intent of this research is to quantify the actual impact that high efficiency filters have on in-home PM concentrations, and it will result in a database of simultaneous measurements of indoor/outdoor aerosol concentrations, system operational values (e.g. run times, pressure drops), and system energy use. This work will directly inform existing ASHRAE Standards including minimum filtration aspects of 62.2-2007, which has been incorporated into existing state energy codes (e.g., for California), and the discharge addendum in 52.2-2007. Finally, this work will provide data to better inform the residential consumer on: 1) IAQ impacts of high efficiency purchases, which were estimated as an annual revenue stream of $150 million to the filter market; 2) how often higher efficiency filters (both standard and electrostatic) should be changed to maintain their effectiveness of PM concentration reduction; and 3) any associated energy costs with using higher efficiency filtration.

1663-RP
RESIDENTIAL IAQ GUIDE

September 2015 – February 2017
Schoen Engineering Inc.
Principal Investigator: Lawrence Schoen
(EHC), Environmental Health Committee

The objective of this project is to develop a document that leads to improved residential indoor air quality by providing practical guidance on actions to take throughout the process of building design construction, and commissioning, including those that affect operation and maintenance.

1666-RP
EXPERIMENTAL EVALUATION OF THE THERMAL AND VENTILATION PERFORMANCE OF STRATIFIED AIR DISTRIBUTION SYSTEMS COUPLED WITH PASSIVE BEAMS

April 2016 – March 2018
Purdue University
Principal Investigator, Qingyan Chen
TC 5.3, Room Air Distribution

The experimental results and recommendations will produce previously unavailable new design and operating guidelines for the combined system of displacement ventilation with passive beams. The improved understanding achieved from this project will allow this promising integrated technology to be considered more confidently by system designers. This will reinforce the value of ASHRAE guidelines to building system designers and help to ensure mechanical system design and installation provides comfort while supporting ASHRAE's net-zero energy design strategies.

1675-RP
GUIDANCE FOR CFD MODELING OF DATA CENTERS

April 2016 – March 2018
Florida International University
Principal Investigator, Cheng-Xian Lin
TC 4.10, Indoor Environmental Modeling; co-sponsored by: TC 9.9, Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

The primary objective of this research project is to provide CFD modeling guidance for data center applications. The guidance will be based on experimental and CFD analyses of several data center configurations to be conducted as part of this study as well as other work available in the literature.

1677-RP
MEASUREMENT AND PREDICTION OF WATERSIDE FOULING PERFORMANCE OF INTERNALLY ENHANCED CONDENSER TUBES USED IN COOLING TOWER APPLICATIONS

September 2013 – February 2018 (P)
University of Illinois
Principal Investigator: Xinlei Wang
TC 8.5, Liquid-to-Refrigerant Heat Exchangers

The objective of this research project will be to: 1) Experimentall7y determine the fouling resistance on smooth and enhanced tubes using water representative of cooling tower applications. Experiments should make use of water having varying levels of fouling potential. In addition to a baseline test using a smooth tube, fouling tests of at least 5 internally enhanced tubes shall be conducted. 2) Using the results of the experimental study, as well as additional data from previous ASHRAE research and other published works, a model of the fouling resistance shall be confirmed, modified, or developed. The model shall not preclude application to non-cooling tower applications,

such as might occur in enhanced tubes applied to evaporators. 3) Propose a generalized calculation procedure or approach to determining an appropriate fouling resistance for a "typical" application of enhanced tubes in a cooling-tower water heat exchanger application. Such a procedure should be suitable for publication as part of ASHRAE or AHRI standards, such as AHRI Guideline E or AHRI Standard 550/590. A method that represents an improvement in accuracy over the current method of specifying a specific, constant fouling resistance regardless of application conditions or enhanced geometry characteristics is desired.

1692-RP
EFFECTS OF SHIELDING ON THE WIND LOADS ON ROOF MOUNTED EQUIPMENT

September 2015 – April 2017 (P)
Insurance Institute for Business & Home Safety
Principal Investigator: Murray Morrison
TC 2.7, Seismic and Wind Resistant Design

The goal of the current research is to examine the effects that architectural screening has on wind loads on roof mounted equipment. To meet this objective an experimental study is proposed to examine the effect numerous screen configuration has on the wind loads on roof mounted equipment.

1696-RP
THERMAL, MOISTURE AND AIR TRANSPORT PROPERTY VALUES FOR NEW BUILDING AND INSULATING MATERIALS

September 2015 – August 2018
Building Science Consulting, Inc.
Principal Investigator: Christopher J. Schumacher
TC 4.4, Building Materials and Building Envelope Performance

The principal justification of this project is to ensure that the hygrothermal materials properties in the ASHRAE Handbook – Fundamentals continue to be representative of the materials currently in use especially in view of the use of different envelope systems and design and HVAC solutions for very low energy and net-zero energy buildings. Designers will be able to more confidently perform hygrothermal modeling to optimize their buildings, as well as promote the advantages of energy and hygric modeling to their clients. The results of this project will support the calculations required in ASHRAE 90.1, 90.2, 189.1, and 160, making those standards easier to use and increasing their likelihood of adoption in more jurisdictions.

1699-RP
UPDATE CLIMATIC DESIGN DATA IN CHAPTER 14 OF THE 2017 HANDBOOK OF FUNDAMENTALS

June 2014 – May 2016
KLIMAAT Consulting & Innovation Inc.
Principal Investigator: Michael Roth
TC 4.2, Climatic Information; Co-sponsored: TC 4.1 Load Calculations

The climatic design conditions in the HOF Chapter 14 are fundamental for the sizing and design of building energy systems to allow for optimal energy efficiency measures and ensure that the design conditions are related to the energy system capacity to meet the climatic loads in a probabilistic sense. Regular updating of the climatic conditions is critical in this respect for many practical reasons and to show due diligence in a world of changing climate.

1702-RP
CASE STUDIES TO TEST PERFORMANCE MEASUREMENT PROTOCOLS

September 2015 – August 2017
University of Wyoming
Principal Investigator: Liping Wang
TC 7.6, Building Energy Performance

The value added by the proposed case studies will significantly benefit building owners, managers, operators, and commissioners by providing them a credible, tested set of measurement protocols with which to evaluate and improve building performance; commissioning providers will especially benefit. Too many claims of improved building performance have been made without the credibility of measured data. Furthermore, the case studies will add credibility to ASHRAE's PMP Special Publication, providing the basis for development of a PMP standard or guideline; a revised second edition is expected to result from this study.

1705-RP
INVESTIGATION OF AIRSIDE FOULING ON OUTDOOR HEAT EXCHANGERS

December 2015 – October 2017
University of Nebraska-Lincoln
Principal Investigator: David Yuill
TC 8.4, Air-to-Refrigerant Heat Transfer Equipment, Co-sponsored by: TC 8.11, Unitary and Room Air Conditioners and Heat Pumps

Heat exchangers are key components in all heating, refrigerating, and air-conditioning systems. Even fractional improvement on heat exchanger performance may have the potential to acquire significant energy savings. The intent of this research is to build a better base of knowledge regarding airside fouling for outdoor heat exchangers and the impact that it has on performance. Based upon this, a fouling test method can be developed. Understanding these impacts and developing a scientifically valid test method that replicates fouling in field observations will help ASHRAE members reduce costs significantly. ASHRAE as a professional society for engineers and building energy professional may help provide fouling information from various resources, particularly operating units retrieved from the field, while still protecting members' interests.

1710-RP
EFFECTS OF DYNAMIC SHADING DEVICES ON DAYLIGHTING AND ENERGY PERFORMANCE OF PERIMETER ZONES

September 2016 – October 2018
Iowa State University
Principal Investigator: Kristin Cetin
TC 4.5, Fenestration

Indoor environment and occupant comfort is a key aspects of ASHRAE's contribution to the industry. The proposed research will provide detailed and accurate results of the measured and verified daylighting performance and lighting energy savings using dynamically controlled shading devices –primarily interior roller shades and venetian blinds, most commonly used in commercial buildings in North America. These results will be beneficial in developing the guidelines for engineers and building designers involved with envelope options and energy use.

1712-RP
DEVELOPMENT OF THE ASHRAE DESIGN GUIDE FOR DEDICATED OUTDOOR-AIR SYSTEMS

June 2014 – November 2016
Sustainable Engineering Group, LLC.
Principal Investigator: Svein Morner
TC 8.10, Mechanical Dehumidification Equipment and Heat Pipes; Co-sponsoring TCs: 1.12, Moisture Management in Buildings, TC 5.5, Air-To-Air Energy Recovery & TC 8.12, Desiccant Dehumidification Equipment and Components

This design guide will help practicing HVAC engineers design dedicated outdoor-air systems that minimize energy use, maximize indoor environmental quality, and balance life-cycle cost with environmental impact.

1717-RP
IMPROVE ACCURACY AND REPRODUCIBILITY OF ASTM-E681 TEST METHOD FOR FLAMMABILITY LIMIT MEASUREMENT OF 2L FLAMMABLE REFRIGERANTS

April 2015 – April 2017 (P)
University of Maryland
Principal Investigator: Peter Sunderland
TC 3.1 Refrigerants and Secondary Coolants

As a consequence of phase-out regulations, the industry is looking to the development of new refrigerants that are both safe and functional. ASHRAE SSPC 34 assesses the safety of submitted newly-proposed refrigerants and offers a safety classification following a peer-review process. With the flammability test challenges posed by some of the new alternative refrigerants, appropriate test modifications need to be identified, confirmed, and incorporated into the test procedure included in ASHRAE Standard 34. With this, the proper flammability classification will be assigned to further ensure safety for both the individual (upon handling and using) and the environment (with the introduction of new alternative low GWP refrigerants).

1719-RP
DESIGN GUIDE FOR COOL THERMAL STORAGE – UPDATE/REVISION

April 2017 – March 2018
GARD Analytics
Principal Investigator: Jason Glazer
TC 6.9, Thermal Storage

ASHRAE is the worldwide recognized authority on the application of thermal energy storage to cooling applications. A recent web search revealed no fewer than eight (8) energy storage conferences slated for a typical year. There is an undeniable realization that energy storage is a critical component of our energy future. It should be recognized that thermal energy storage is one of the few (if not the only) storage technologies that has developed into a commercially successful, economically justifiable, widely accepted system for individual buildings or multi-building facilities. ASHRAE must maintain its leadership role in this technology by providing accurate, current and complete design guidance – guidance only obtainable through the technical expertise of ASHRAE.

1721-RP
OIL RETURN AND RETENTION IN UNITARY SPLIT SYSTEM GAS LINES WITH HFC AND HFO REFRIGERANTS

April 2017 – March 2019
Purdue University
Principal Investigator; Eckhard Groll
TC 8.11, Unitary and Room Air Conditioners and Heat Pumps
Co-sponsored by: TC 10.3 Refrigerant Piping, Controls and Accessories; TC 3.4, Lubrication

The objective of this project will be to develop rules for sizing refrigeration interconnecting gas piping in unitary split systems to ensure oil return to the compressor in both air-conditioning and heat pump applications. Both horizontal and vertical lines would need to be addressed. The rules that are developed would be such that they would be applicable to all existing refrigerant-oil combinations currently in use as well as new combinations currently under investigation. The results would be published in the next available edition of the ASHRAE Refrigeration Handbook.

1724-RP
STUDY THE HVAC SYSTEM PHOTODEGRADATION CAUSED BY THE LOW LEVEL UVC LIGHT IRRADIANCE USED FOR COIL MAINTENANCE AND AIR STREAM DISINFECTION

April 2015 – April 2017 (P)
University of Dayton Research Institute
Principal Investigator: Robert Kauffman
TC 2.9, UV Air & Surface Treatment

This research would be supportive of ASHRAE's Research Opportunities Themes A and B. UVC has been used to save air conditioning energy costs, reduce maintenance and improve Indoor Environmental Quality. Specifically, goal A1 of reducing building energy by 30% and goal A6 which hopes to develop best practice methods that will allow energy consumption, life cycle cost, and environmental impact to be minimized, and that will allow system life span and IEQ to be maximized. The results of the research will remove barriers to the use of UV for these savings.

1729-RP
EXPERIMENTAL VERIFICATION OF COOLING LOAD CALCULATIONS FOR SPACES WITH NON-UNIFORM TEMPERATURE RADIANT SURFACES

September 2016 – August 2018
University Texas Austin
Principal Investigator: Atila Novoselac
TC 4.1, Load Calculation Data and Procedures
Co-Sponsors: TC 5.3, Room Air Distribution

The results of the project will improve the cooling load methods described in ASHRAE Handbook of Fundamentals by enhancing their applicability to radiant systems that utilize radiation heat transfer to directly remove space heat gains from the conditioned space. Knowledge of the dynamic interaction of radiant systems with various heat sources will produce guidelines for modeling space conditioning systems that involve radiation heat transfer, which include radiant and stratified systems (UFAD and displacement ventilation) that will create non-uniform surface temperatures in the space. The results and improved modeling methods from this project could also be used in future efforts to update the Radiant Time Series method for radiant cooling applications or the weighting factor method for energy performance modeling.

1734-RP
REPRODUCING A REPRESENTATIVE URBAN ATMOSPHERIC AEROSOL DISTRIBUTION AT HIGH CONCENTRATION IN THE LABORATORY FOR AIR FILTER AGEING TO BE USED IN ASHRAE GPC 35P FOR DETERMINING THE ENERGY CONSUMPTION CAUSED BY AIR FILTERS

August 2017 – July 2019
Purdue University
Principal Investigator: Brandon Boor
TC 2.4, Particulate Air Contaminants and Particulate Contaminant Removal Equipment
Co-sponsored by: SSPC 52. Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size

The results from this work statement would affect the energy usage and design criteria for several ASHRAE Handbook Chapters and Standards. The Handbook chapters that would be affected are Chapter 29 - Air Cleaners for Particulate Contaminants, HVAC Systems and Equipment Handbook; and Chapter 46 - Control of Gaseous Indoor Air Contaminants, Applications Handbook.

1741-RP
UNDERSTANDING FAN COIL COMPONENTS AND HOW THEY RELATE TO ENERGY CONSUMPTION AND ENERGY MODELING

January 2017 – December 2019
University Louisiana Lafayette
Principal; Investigator:
TC 5.3, Room Air Distribution
Co-sponsored by: TC 7.7, Test & Balance

The experimental results and recommendations will result in previously unavailable part load capacity and efficiencies maps for fan coil systems. The new tools and modeling options developed will improve the ability of design engineers to evaluate and predict the energy and comfort performance of buildings using fan coil systems. The better understanding of efficiencies at part load operations achieved from this project will allow more confident applications by system designers. This will reinforce the value of ASHRAE guidelines to building systems, and support ASHRAE's net-zero energy design strategies. This research will be of great value to the Engineering community, and provide more pertinent and accurate information in the selection of fan coils for any given application. In obtaining the accurate information needed for fan coil selection, sizing issues will decrease and reduce overall energy consumption significantly.

1742-RP
UPDATE TO MEASUREMENTS OF OFFICE EQUIPMENT HEAT GAIN DATA

April 2016 – September 2017
Oklahoma State University
Principal Investigator, Christian Bach
TC 4.1, Load Calculation Data and Procedures

The main objective of this research is to update the widely used data that has been included in that Fundamentals Handbook Cooling Load Chapter. The desired outcome is to develop data that is very similar to that which was developed previously but reflecting the new generation of equipment that is widely used today.

1743-RP
EFFECT OF INLET DUCT AND DAMPER DESIGN ON ASHRAE 37/116 FAN PERFORMANCE AND STATIC PRESSURE MEASUREMENTS

August 2017 – July 2018
Oklahoma State University
Principal Investigator: Christian Bach
TC 8.11, Unitary and Room Air Conditioners and Heat Pumps

The major benefit of this project is to provide technical clarification to HVAC testing laboratories when testing samples. This subject impacts all users of unitary air-conditioning equipment such as DOE, California Energy Commission, independent test facilities and manufacturers of unitary equipment. Standardization will provide more consistent setups and repeatability between manufacturer's laboratories and 3rd party certification laboratories.

1746-RP
VALIDATION OF RP-1455 ADVANCED CONTROL SEQUENCES FOR HVAC SYSTEMS – AIR DISTRIBUTION AND TERMINAL SYSTEMS

December 2015 – November 2018
Pennsylvania State University
Principal Investigator: Stephen Treado
TC 1.4, Control Theory and Application

This project validates the advanced control sequences developed in RP-1455 research project in a real- world building environment with a modern commercial-grade direct digital control system. It will make sure these advanced control sequences are implementable on a commercially available modern direct digital control system for the most common air distribution types. It will validate the actual control and HVAC system performance under various real-world heating and cooling conditions. It will develop and implement functional tests procedures, which will be incorporated into Guideline 36 to allow manufacturers to test their implementation of the RP-1455/Guideline 36 sequences. It will provide feedback to ASHRAE GPC 36 to improve sequences, reduce ambiguities, fix bugs, adjust tuning parameters, etc.

1747-RP
IMPLEMENTATION OF RP-1547 CO2-BASED DEMAND CONTROLLED VENTILATION FOR MULTIPLE ZONE HVAC SYSTEMS IN DIRECT DIGITAL CONTROL SYSTEMS

September 2015 – February 2017
University of Alabama
Principal Investigator: Zheng O'Neil
TC 4.3 Ventilation Requirements and Infiltration
Co-sponsored by: TC 1.4 Control Theory and Application

This research project will provide the following: Practical sequences for VAV system DCV, articulated in English and represented in a logic flow diagrams. Simulation studies to evaluate energy and ventilation performance, including the impact of sensor error. Functional performance test scripts to allow for field or factory commissioning of DCV sequences. Thorough field testing of the sequences to ensure stability under a wide variety of operating conditions. Greatly simplified design procedure for HVAC engineers, which will result in significant reduction in engineering effort and eliminate the errors commonly found in applying Standard 62.1's Multiple Spaces Equation.

1755-RP
IMPACT OF GASEOUS CONTAMINATION AND HIGH HUMIDITY ON THE RELIABLE OPERATION OF INFORMATION TECHNOLOGY EQUIPMENT IN DATA CENTERS

July 2016 – June 2018
Syracuse University
Principal Investigator, Jianshun Zhang
TC 9.9, Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment;
Co-sponsored by: TC 2.3, Gaseous Air Contaminants and Gas Contaminants Removal Equipment

The project will address the impact that gaseous contamination has when adopting the expanded thermal guidelines for data processing equipment. Specifically, it will look at the impact that the expanded acceptable humidity envelope has on IT equipment reliability when subject to environments that have higher than normal concentrations of gaseous contaminants.

1766-RP
DEVELOPMENT OF A UNIFIED TOOL FOR ANALYSIS OF ROOM LOADS AND CONDITIONS

December 2015 – November 2016
Building and Systems Analytics LLC
Principal Investigator: Charles Barnaby
TC 6.5, Radiant Heating and Cooling

The objective of the proposed work is to produce a unified space analysis application that calculates and displays room conditions, heating and cooling loads (delivered by air-based and/or radiant systems), and mean radiant temperature (MRT). We provisionally name this application RPEHB, since it is an integration of RPE with the HB (heat balance) load calculation method. The inputs for RPEHB calculations will be room shape, construction, operational requirements (e.g. control set points), and design-day weather conditions. Preparation of geometric input data will be supported by import from 3D tools such as SketchUp.

1767-RP
MOIST AIR TRANSPORT PROPERTIES RESEARCH

July 2016 – December 2017
Kretzschmar Consulting Engineers
Principal Investigator: Hans-Joachim Kretzschmar
TC 1.1,Thermodynamics & Psychrometrics

The objective is to make the ASHRAE technical literature and ASHRAE Handbook of Fundamentals the most current and most accurate source of data for the transport properties of the substances air, moist air, and water. Therefore, new SI and IP Moist Air Property tables *Transport Properties of Moist Air at Standard Atmospheric Pressure (101.325 kPa)* for the ASHRAE Handbook of Fundamentals, Psychrometrics Chapter will be prepared. The new tables will contain values for viscosity, thermal conductivity, temperature diffusivity, Prandtl number, and kinematic viscosity, as well as density at atmospheric pressure in the temperature range of −70 to 300°C. This incorporates the research of Lemmon and Jacobsen (2004) for dry air viscosity and thermal conductivity, the International IAPWS standards on the properties of H2O for viscosity and for thermal conductivity as well as the latest International values for the Universal Gas Constant and the Relative Molar Masses of H2O and the gases that make up dry air.

1771-RP
ENERGY MODELING OF TYPICAL COMMERCIAL BUILDINGS IN SUPPORT OF ASHRAE BUILDING ENERGY QUOTIENT ENERGY RATING PROGRAM

April 2016 – March 2018
University of Miami
Principal Investigator, Wangda Zuo
bEQ, Building Energy Quotient Energy Rating Program
Co-sponsored: TC 7.6, Building Energy Performance, TC 4.7, Energy Calculations

The overall objective of the proposed research is to reconcile the differences between the empirical and modeled baselines for energy performance comparison for new commercial building designs and existing commercial buildings, allowing seamless translation of building energy performance metrics among LEED, Standard 90.1, Standard 189.1, Standard 100, and the bEQ *As Designed* and *In Operation* ratings. The proposed research will contribute to a better understanding of the role of neutral variables in building energy modeling predictions. The research will also lead to consistency of energy performance metrics for Standard 90.1 (and LEED), Standard 189.1, and Standard 100.

1774-RP
EFFECTS OF SYSTEM CHEMICALS ON THE BREAKDOWN OF LUBRICANTS AND LOWER GWP REFRIGERANTS

September 2016 – August 2017
Spauschaus Associates
Principal Investigator: Ngoc Dung T Rohatgi
TC 3.2, Refrigerant System Chemistry
Co-sponsored by: TC 3.3, Refrigerant Contaminant Control and TC 3.4, Lubrication

Information is needed to ensure short- and long-term reliability of air-conditioning and refrigeration equipment using lower GWP refrigerants and synthetic lubricants. Contaminants in refrigerant systems can lead to lower efficiency or even system failure, and there have been no study published to date on the potential process chemical reactivity with lower GWP refrigerants compared to currently applied system chemistries. Process chemicals in use today are not expected to change as refrigerant chemistries are changed; thus, it is necessary to understand the magnitude of any increased system chemistry risks with lower GWP refrigerants, to identify classes of contaminants that could potentially promote breakdown, and compare these risks to those managed today.

1785-RP
EXPERIMENTAL VALIDATION OF REFRIGERANT CHARGE MODELS IN COILS FOR RESIDENTIAL SPLIT SYSTEMS

August 2017 – January 2020
Oklahoma State University
Principal Investigator: Christian Bach
TC 8.11, Unitary and Room Air Conditioners and Heat Pumps
Co-sponsored by: TC 8.4, Air-to-Refrigerate Heat Transfer Equipment and TC 6.3, Central Forced Air Heating and Cooling Systems

This project will improve equipment models so that they may more accurately reflect the real performance of actual systems in the field. This is of value to BEM practitioners as well as to equipment designers. The ASHRAE Handbook of Fundamentals (2013) outlines several energy modeling tools that are widely used in the industry (e.g., DOE2, EnergyPlus, TRNSYS) and the current methodologies for equipment modeling (Regression Models and First-Principle Models). Unitary split systems, especially heat pumps, which are used widely in both Residential and

Commercial applications pose unique challenges. Since not every rated split system match is lab tested, modeling is leaned on heavily. A weak link in this process is refrigerant charge inventory. Improving the robustness of charge migration modeling will result in greater confidence in the design and selection process for engineers in the field, rating agencies, and manufacturers.

1806-RP
FLAMMABLE REFRIGERANTS POST-IGNITION SIMULATION AND RISK ASSESSMENT UPDATE

January 2017 – December 2017
Gexcon, US
Principal Investigator: Scott Davis
Sponsoring Committee: MTG.LowGWP

The objective of this project is to understand the Severity of events where flammable refrigerants are ignited under different scenarios for various HVAC&R products. Such understanding will allow for the assessment of the overall risks of using flammable refrigerants in HVAC&R products, taking into account both event Probability and Severity.

1807-RP
GUIDELINES FOR FLAMMABLE REFRIGERANT HANDLING, TRANSPORTING, STORING AND EQUIPMENT SERVICING, INSTALLATION AND DISMANTLING

March 2017 – August 2017
Navigant Consultant Inc.
Principal Investigator: William Goetzler
Sponsoring Committee: MTG.LowGWP

This proposed project will investigate current information related to installation practices as well as servicing and handling aspects for all equipment that use A2, A2L and A3 refrigerants. There are varied skill levels that exist within the HVAC&R industry in the US, and introduction of flammable refrigerants could increase the need for specialized processes, training, and/or certifications as part of risk mitigation.